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Original Article

Sensomotor integration features in skilled female boxers

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Abstract:
The paper considers features of sensomotor integration of visuomotor reactions in female boxers. It is found that sportswomen have quicker reactions, but make more mistakes in complex choice reaction. Sensomotor integration of sensomotor reaction into functional systems of activity in female boxers is also associated more with accuracy of responsive actions than in reaction rate.
Keywords: sensomotor reactions, sensomotor integration, women's boxing, skilled boxers.

Introduction

In 2012 women's boxing was included in the program of Summer Olympics, and since then it has been gaining popularity in the world [Shakhov, Damadaeva, 2012; Tcherkasova, 2013]. Women's boxing has features of surrogate sports, so it is expected that many highly skilled sportswomen are born with male somatotype as at birth they have large body mass (macrotype of physical development) and masculine dermatoglyphics [Sultanova, 2012]. However women boxers are inferior in development of speed, speed-power and other physical properties to male athletes [Vrublevskiy,2008; Sokha, 2002].

Boxing is an arduous combative sport. The success of the sportsman's competitive strategy depends largely on efficiency of sensomotor integration that provides quickness and adequacy of the boxer's responsive actions (physical and operational actions) under time shortage and situational course of fighting [Korolev,2013; Charykova, 2009].

Women's essential ambition to achieve high sport performance requires full-scale scientific substantiation and sets several topical issues for scientists and experts. One of these issues is study of features of sensomotor integration in functional systems of motor activity in women boxers. Sensomotor integration effectiveness allows formation of potent adaptive strategies in competitive fighting [Wolpert et al., 1995; Del Parcio et al., 2009; Le Runigo et al., 2010].

Materials and methods

We examined 20 skilled boxers – participants and winners of national and international competitions at the age of 20-25 during precompetition training for the Russian Championship. All boxers were divided into 2 groups by gender (10 athletes in each group): 1 group – women boxers (weight categories: from 51 to 64 kg); 2 group – men boxers (weight categories: from 52 to 75 kg).

The research was conducted in the morning, at relative physiological rest. Before each test athletes received preliminary instruction that was always followed by the tentative testing. We used psychophysiological hardware-software complex "Psikhotest" produced by "OOO "Neyrosoft"" (LLC), Ivanovo [Mantrova, 2001].

Rate of visuomotor reactions was measured under different conditions: simple (simple visuomotor reaction - SVMR) and complex (choice reaction – CR; discrimination reaction – DR and reaction to a moving object – RMO). Accuracy of reactions was calculated using Whipple's index (ratio between wrong reactions and total of presented signals). Basing on ratio of forward and deferred reactions we calculated balance of excitative and inhibitory processes [Mantrova, 2001].

The present functional status of the central nervous system (CNS) was defined using three criteria offered by T.D. Loskutova: functional level of the system (FLS), stability of reactions (SR) and level of functional capabilities (LFC). FLS is specified by absolute values of SVMR time; SR is interpreted as CNS stability; LFC suggests that the examined is able to form the functional system appropriate for the task and to keep it long enough [Mantrova, 2001].

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For processing of the results we used program Statistica 6.0. Significance of differences between two gender-specified groups of boxers was defined using Mann-Whitney U test and Fisher's ratio test. Correlation analysis was performed using Spearman's rho [Rebrova, 2002].

Results

At the moment of research all athletes had optimal functional status for precompetition training period, so we were able to start the main research without correcting the sample of athletes.

Mean group results of rate both for simple and complex reactions in skilled boxers did not have gender-related significant differences ($p>0.05$) (Table 1).

Table 1. Visuomotor reaction rate in skilled boxers under different conditions

Reaction rate	Groups		Z	p
	women	men		
SVMR, ms	208.8 ±7.71	202.3 ± 6.71	0.62	0.54
CR, ms	334.5± 9.24	345.3 ±12.33	0.71	0.48
DR, ms	323.3 ± 8.1	311.5 ± 12.12	0.82	0.41

Visuomotor reaction rate under simple conditions of boxers' reacting was within average range. Analysis of individual distribution of SVMR time also showed that almost half of athletes without regard to gender (50% of women and 50% of men) demonstrated average rate of reactions that was not corresponding with the literature data [Shayakhmetova, 2008; Pascolo, 2013]. On contrary, average rate of CR had high value and did not as well depend on gender ($p>0.05$). Analysis of individual distribution of choice reaction rate demonstrated the absence of low values without regard to group. Most women and men (80% and 60%, respectively) reacted very quickly under these conditions.

Average rate of DR representing the mobility of the nervous processes was the same in men and women ($p>0.05$) and had high value. High mobility of nervous processes was observed in absolute majority of men 100% and majority of women 80% in examined samples. High mobility of nervous processes specifies quick transition of motor nervous centers from excitation and inhibition thus providing high rate of movements, transition from one type of movements to others, re-skilling of old technique, correction of mistakes, mastering of new techniques, adjustment to opponents with various fighting strategies and tactic changes [Sokha, 2002; Ilyin, 2003; Markov, 2011]. Under competitive activity the boxer is able to transit from attack to defense and vice versa. The central time of excitation transition delay defined from difference between results of simple visuomotor reaction and discrimination reaction rates was increased both in men and in women. According to literature data, increase of the central time of excitation transition delay is associated with initial signs of functional status deterioration and developing disadaptation processes [Ilyin, 2003]. This fact may also result from decreased performance of sensomotor regions of cerebral cortex in boxers due to frequent head blunt injuries [Di Russo et al., 2009].

Whipple's index (WI) allows estimation of reaction accuracy in athletes [Di Russo et al., 2009]. Women boxers do not differ from men in accuracy of all examined reactions ($p>0.05$ in all cases). Athletes from all examined samples showed the least accuracy in choice reactions, together with high rate of these reactions (Table 2).

Table 2. Comparative characteristics of accuracy of reaction rate in skilled boxers under different conditions

Indices	Groups		Z	P
	women	men		
WI (SVMR), cu	0.04 ±0.01	0.05 ±0.01	0.76	0.45
WI (CR), cu	0.13± 0.02	0.10± 0.02	1.43	0.16
WI (discrimination reaction), ms	0.01 ± 0.01	0.04 ± 0.01	0.65	0.52

Analysis of athletes' distribution within group by accuracy of choice reactions as the very frequent reactions in boxer's competitive activity also showed low level of one of the most important reactions in boxing. The majority of women boxers (80%) make too many mistakes in choice reactions. Though the majority of men boxers demonstrate low accuracy (50%), 30% make very few mistakes. Differences in low accuracy rate are statistically significant according to Fisher's test ($p<0.05$).

There are no differences in accuracy of discrimination reactions (DR) between boxers of both genders. All athletes do not only change from attack to defense and vice versa, but also show high accuracy of physical and operational actions under these conditions. Low accuracy of discrimination reactions was observed almost equally in women and men boxers (10% and 20% respectively).

Rate of reactions to a moving object (RMO) in boxing specifies the ability to duly react to the opponent's blow without losing power and direction of attack or letting the responsive punch through. RMO rate

is an indirect indicator of balance of nervous processes. Athletes with significantly prevailing excitations try to be ahead of the opponent's actions and, as a result, launch "glancing blows". The similar is observed in the opposite situation, when the blow is delayed, but in this case it is much more probable to get knocked down. Analysis of experiment results showed that RMO in women boxers had more significant time advance than in men boxers (as a tendency) (Table 3).

Table 3. Comparative characteristic of reaction to a moving object in skilled women and men boxers

Indices	Groups		Z	p
	women	men		
RMO, ms	-4.52 ±2.56	0.28 ±2.47	1.34	0.19

The system approach in analysis of sensomotor integration in boxers of both genders basing on correlation analysis allowed revelation of differences in effectiveness of cooperation between different levels of hierarchy of the motor activity functional systems. If the functional status of the CNS is optimal the intrasystem sensomotor integration of functional system of visuomotor reactions is presented with larger number of correlations (Fig. 1).

Correlation analysis for men boxers demonstrated direct strong correlations between indices of different reactions (Fig. 1). At this training stage, in men boxers we observe many correlations with Whipple's index (WI) specifying the amount of wrong actions [Rebrova, 2002]. Direct correlation is between simple visuomotor reaction rate and number of mistakes in choice reactions and discrimination reactions. Such intrasystem integration lets boxer effectively and unexpectedly change from attacking actions to defense and vice versa, from maneuvering to attacking and counter-attacking.

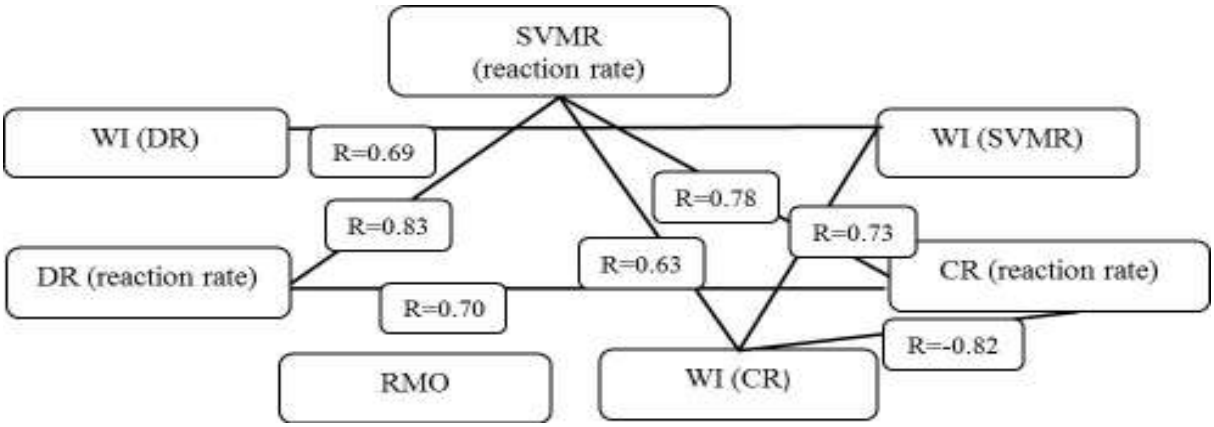

Fig. 1. Diagram of sensomotor integration of activity of visuomotor reaction functional system in skilled men boxers

Specifics and directions of correlations and, consequently, effectiveness of sensomotor integration in activity of functional system of movements in women boxers were different (Fig. 2).

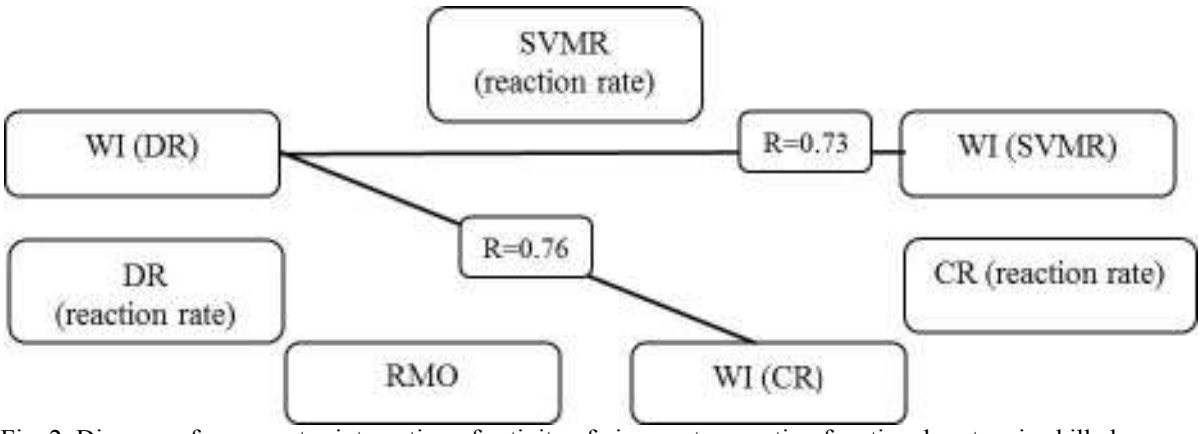

Fig. 2. Diagram of sensomotor integration of activity of visuomotor reaction functional system in skilled women boxers

Results of reaction accuracy defined with Whipple's test have strong correlation in women. Boxers making a few mistakes in discrimination reactions (mobility of nervous processes) make a few mistakes both in

simple reactions and in choice reactions. "Triangle" of direct correlations between reaction rates (excitability of nerve centers and mobility of nervous processes) observed in men boxers under different conditions is absent in women's functional system.

Discussion

Thus, sensomotor integration in women boxers differs from one in men boxers in specifics of cooperation of different components. Sensomotor integration in sportswomen is manifested more in accuracy of responsive actions under both simple and complex conditions. Quantitative indices of reaction rates do not differ on the basis of gender and have high values providing quickness of reaction in situational conditions of fighting. As men, women make the most mistakes in choice, rather than in discrimination reactions. However in complex conditions of choice women show more inaccuracy in responsive actions than sportsmen. Revealed features of rate and accuracy of sensomotor reactions, and effectiveness of sensomotor integration should be used in development of physical and operational training of women boxers.

Conclusions

1. Women boxers have high rate of reactions, but less accuracy in complex reactions of choice in comparison with men that is one of the reasons of lower performance of physical and operational actions of sportswomen.

2. Sensomotor integration in activity of functional system of visuomotor reactions in women boxers is manifested more in accuracy of responsive actions than in reaction rate that is probably used as prevention of large number of wrong physical and operational actions.

3. Features of sensomotor integration of functional system of sensomotor reactions in women boxer require further specification in different phases of ovarian menstrual cycle for correction and individualization of training programs for highly skilled sportswomen.

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